Exploiting Codified User Task Knowledge to Discover Services at Design-Time

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ABSTRACT

Most techniques for engineering service-based applications do not explicitly exploit knowledge about users and their tasks. In this paper the authors hypothesize that codified knowledge about user tasks can improve service discovery at design-time. It reports the extension of an existing service discovery algorithm to match service queries to user task models then reformulate the service queries with task-specific knowledge in order to improve discovery precision and recall scores. An empirical investigation of the extended algorithm revealed that, in order to deliver significant benefits, user task models need to describe more context-specific knowledge with which to extend service queries.

Keywords: Codified User Task Knowledge, Design-Time, Service Discovery, Service-Based Applications, User Task Models

INTRODUCTION

Service-oriented computing increases the number of mechanisms through which software can adapt to its context (Daniele et al., 2009). Whilst established context factors such as time and location have been applied to the design of service-based applications (Bucchiarone et al., 2010; Marconi et al., 2009), one factor often overlooked in service-oriented computing is the user task. Service-based applications that invoke services adapted to the user task have the potential to enable the user to achieve the task goal more effectively than applications not adapted to the task. However, there has been little research to explore this potential.

User task modeling has been the subject of research in human-computer interaction since the 1980s. User task analysis (Diaper, 2003) and models (Paterno, 2002) are well-understood concepts. However, there have been few applications of user task models to the design or delivery of service-based applications, although...
exceptions do exist (Kritikos & Paterno, 2002). Run-time service environments would be able to select, compose and invoke services that would explicitly fit with the goals and constraints of the user task, and design-time environments would be able to overcome ontological mismatches between user requests and descriptions of the software services to meet these requests (Dourdas et al., 2006). For example, without knowledge of the user task such as drive to a destination and which classes of service to invoke to support a task, a motorist’s need for an accurate estimated time of arrival at a destination cannot be associated to software service descriptions for journey planning, weather forecasting and roadwork alerts. Therefore, in the research reported in this paper, we investigated whether codified user task knowledge can deliver some of these potential advantages to the design of service-based applications.

User task knowledge structures are based on a methodological approach to modeling tasks (Johnson & Johnson, 1991) that assume that when humans learn procedural facts that pertain to the same topic, the knowledge is grouped in coherent wholes so that it can be recalled and used as a unit. Current approaches to designing service-based applications do not exploit codified knowledge about user tasks. Business process models and notations such as BPEL (2007) and BPMN version 2.0 (2011) indicate the process-oriented context in which services need to be invoked, however these models often lack important information about the actors performing the processes, and their goals, actions and constraints. Although initiatives such as BPEL4People (2007) and the HpS Framework (Shall et al., 2008) attempt to incorporate human considerations into the specification of business processes, they are limited to describing human activities as simple processes and do not codify knowledge about users and their tasks.

In contrast, codified user task models have the potential to provide different types of knowledge with which to improve the design of service-based applications. Examples of this knowledge include the end-state that the user is trying to achieve with the task, the different types of cognitive or interactive sub-task undertaken, and the concrete physical, financial and time resources needed to undertake each sub-task. Our research starts from the position that a design-time environment can exploit knowledge of these types to discover services that meet the user’s goals and resource needs, compose services to support cognitive and interactive tasks more effectively, and invoke services that provide resources that users need.

In particular, in this paper, we report an extension of an existing service discovery engine to use codified, class-level user task models to add task-specific knowledge to service queries during the design of service-based applications. Our primary aim is to inform decision-making about the architecture of service-oriented systems in the context of available services, and we report techniques to this effect, although the techniques also have the potential to be used in run-time service discovery. The user task models were developed at the class-level (e.g. drive to a destination) to maximize the leverage of each model during service discovery – one model could potentially be exploited during the design of all service-based applications that instantiate that task class (e.g. drive from London to Paris via the Channel Tunnel). We also report an empirical evaluation that investigated the effect of modifying service queries with codified user task models on the precision and recall of the service discovery engine. Results from this investigation are discussed to propose future, effective uses of user task models in design-time service discovery.

The remainder of this paper is in six sections. the first two sections report current user task modeling and analysis approaches and their use in the development of service-based applications. The section afterwards describes the new approach developed in the S-Cube project to exploit user task models in service discovery, then we describe how user task models were codified and used in the design-time service discovery process. Followed by reports the method and results from a multiphase evaluation study that investigated the effect of
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